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(54) Optical fibre sensors

(57) A sensor includes an optical fibre and in use of the sensor the area of contact between the fibre and a liquid varies in dependence on variations in a parameter to be sensed and the optical power output of the fibre varies correspondingly. In an inclination sensor the fibre (2) extends through a tube (1) containing a quantity of the liquid (5) but it is not in contact therewith unless the fibre and tube are tilted out of the horizontal. In a depth sensor the liquid is the liquid whose depth is to be sensed. The fibre may be clad with the liquid acting as an index matching liquid in strip optical power therefrom.

Fig.1.

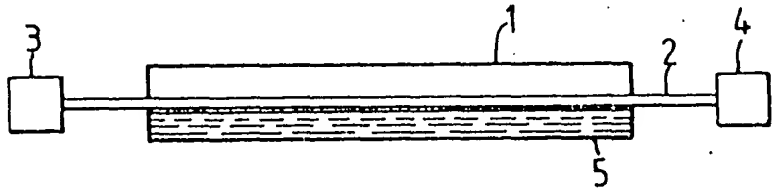


Fig.2.

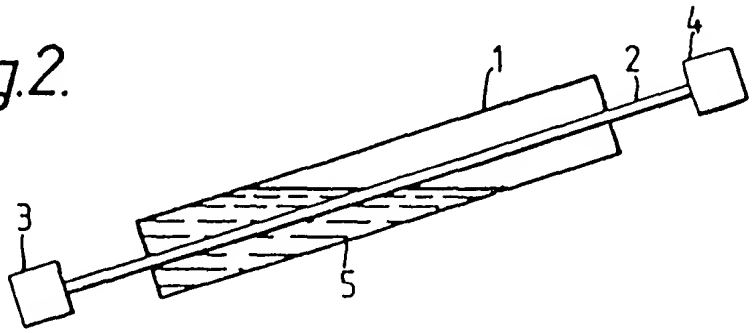


Fig.1.

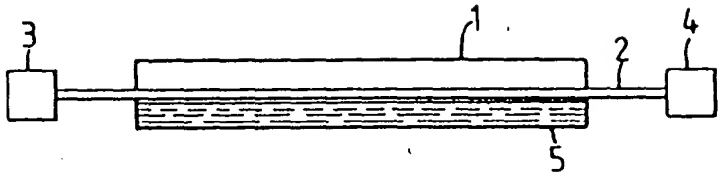


Fig.2.

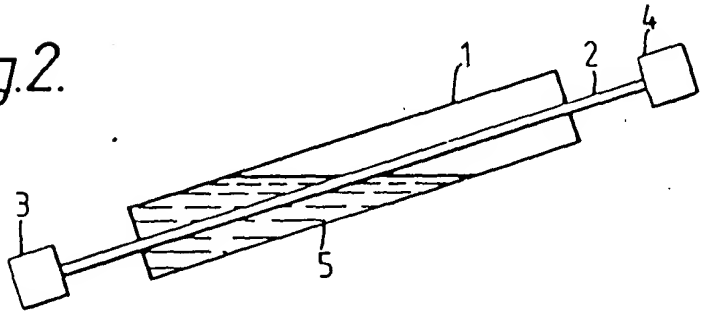
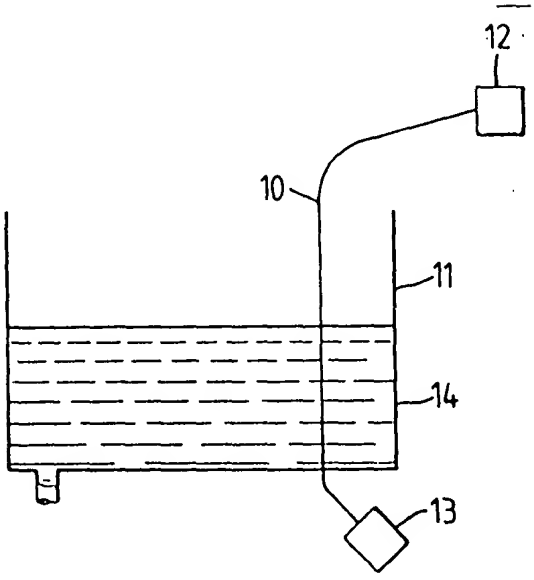


Fig.3.



SPECIFICATION

Optical fibre sensors

This invention relates to optical fibre sensors and methods of sensing with optical fibres.

According to one aspect of the present invention there is provided a sensor including an optical fibre, means to couple optical power into one end of the fibre and detect the optical power throughput, and wherein in use the area of contact between the optical fibre and a liquid varies in dependence on variations in a parameter to be sensed and the optical power throughput varies correspondingly.

According to another aspect of the present invention there is provided a method of sensing a parameter comprising coupling optical power into an optical fibre, detecting the optical power throughput and disposing the fibre relative to a liquid whereby the area of contact between the fibre and the liquid varies in dependence on variations in the parameter to be sensed, the optical power throughput varying correspondingly.

Embodiments of the invention will now be described with reference to the accompanying drawings, in which:

Figure 1 illustrates an embodiment of level sensor in a first level, orientation;

Figure 2 illustrates the embodiment of Fig. 2 in a second, tilted, orientation, and

Figure 3 illustrates an embodiment of depth sensor.

The optical fibre sensor shown in Figs. 1 and 2 is a level or inclination sensor of the spirit level type. It comprises a cell or tube 1 through which extends an optical fibre 2. Coupled to one end of fibre 2 is a light source 3, for example a semiconductor laser or an LED, whereas the light output from the other end of the fibre 2 is applied to a detector 4.

The cell 1 contains a liquid 5, the amount of which is such that when the cell is level, i.e. the fibre is horizontal, the fibre is not in contact with the liquid (Fig. 1). As the cell is rotated (tilted) the fibre will be contacted by the liquid (Fig. 2.) with the angle of rotation being proportional to the area of liquid in contact with the fibre and the transmitted optical power varying accordingly, provided the cell is of a suitable length. If the cell is too long a saturation will arise at a particular angle.

The liquid employed is related to the type of fibre. For a clad or leaky optical fibre the liquid may be an index matching fluid, in which case the greater the angle of tilt the less the optical power detected by detector 4, since optical power will be stripped from the fibre by the index matching fluid at the contact area therebetween. For an unclad fibre the liquid may be mercury, in which case as the cell is rotated the optical power throughout increases, since the mercury wh[illegible] coating.

The embodiment of Fig. 2 employs an optical fibre to sense the depth of liquid in a tank, for example fuel in a motor vehicle fuel tank, and thus provide an indication of the state of fill of the tank. A sensing optical fibre 10 is arranged to extend substantially vertically in a tank 11 in the embodiment illustrated. Coupled to one end of the fibre 10 is a light source 12, for example a semiconductor laser or an LED. The light output from the other end of the fibre is applied to a detector 13.

The optical power transmitted to the detector 13 will vary in dependence on the depth of liquid 14 in the tank, in a manner similar to level sensor described above, since the contact area between the liquid and the fibre will vary and thus depending on the fibre and liquid types there will be variations in the amount of optical power stripped from the fibre or variations in optical power increase due to reflection.

The sensing optical fibre is shown coupled directly to the light source 12 and detector 13 it may however be coupled thereto by other optical fibre end terminations dependent on the type of fibre used for the sensing fibre and the remoteness from the tank of the light source and detector. In the case of a sensing fibre comprised by a conventional clad optical fibre such end terminations will be unnecessary, however in the case of a leaky sensing optical fibre they will be desirable if the light source and detector are remote. The type of sensing fibre used is related to the liquid in the tank. In the case of liquids which act to strip optical power from the sensing fibre and thus as index matching fluids, clad or leaky optical fibre will be employed as the sensing fibre. In the case of mercury or liquids which act in a similar way to mercury to provide a reflective coating on the fibre, unclad sensing fibre would be employed.

In such a depth sensor it is not necessary that the sensing optical fibre is vertical, it can be arranged at an angle to the vertical or otherwise arranged in accordance with the tank configuration and the detector output calibrated accordingly. Since there are no direct electrical connections the depth sensor is particularly suitable for use in a combustible environment, such as a motor vehicle fuel tank.

Although optical power output (throughput) is detected at the other end of the fibre in the embodiments described, it would alternatively be possible to provide an optical reflector at said other end, and to detect the change in power throughput at the input end of the fibre.

CLAIMS

1. A sensor including an optical fibre, means to couple optical power into one end

contact between the optical fibre and a liquid varies in dependence on variations in a parameter to be sensed and the optical power throughput varies correspondingly.

2. A sensor as claimed in claim 1 for sensing the inclination of the fibre, wherein the fibre extends through a tube containing a quantity of liquid, comprising said liquid, such that when the fibre and tube are horizontal the fibre is not in contact with the liquid and such that when the fibre and tube are tilted out of the horizontal the fibre is contacted by the liquid and the optical power throughput changes in dependence on the angle of tilt.

3. A sensor as claimed in claim 1 for sensing the depth of a liquid, comprising said liquid, in a tank, wherein the fibre extends, in use of the sensor, in the tank and the area of contact between the fibre and the liquid and the optical power throughput varies in accordance with the depth of liquid in the tank.

4. A sensor as claimed in any one of the preceding claims wherein the fibre is unclad and the liquid is mercury or another liquid which acts to provide a reflective coating when in contact with the fibre.

5. A sensor as claimed in any one of claims 1 to 3 wherein the fibre is a clad fibre and the liquid is an index-matching liquid or another liquid which serves to strip optical power from the fibre upon contact therewith.

6. An optical fibre sensor substantially as herein described with reference to Figs. 1 and 2 or Fig. 3 of the accompanying drawings.

7. A method of sensing a parameter comprising coupling optical power into one end of an optical fibre, detecting the optical power throughput and disposing the fibre relative to a liquid whereby the area of contact between the fibre and the liquid varies in dependence on variations in the parameter to be sensed, the optical power throughput varying correspondingly.

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